

Claims

[c1] What is claimed is:

1.A method for making a conductive plug, comprising:
providing a substrate having thereon a diffusion region;
depositing a dielectric layer on the substrate;
forming an opening in the dielectric layer, the opening
exposing a part of the diffusion region of the substrate;
depositing a first non-doped silicon layer in the opening;
in-situ depositing a first transient pure phosphor film on
the first non-doped silicon layer in the opening, wherein
phosphor atoms of the first transient pure phosphor film
diffuse into the first non-doped silicon layer in no time
to form a first doped silicon layer; and
in-situ depositing a second non-doped silicon layer on
the first doped silicon layer in the opening.

[c2] 2.The method of claim 1 wherein after depositing the
second non-doped silicon layer on the first doped silicon
layer, the method further comprises the following steps:
in-situ depositing a second transient pure phosphor film
on the second non-doped silicon layer in the opening,
wherein phosphor atoms of the second transient pure
phosphor film diffuse into the second non-doped silicon

layer in no time to form a second doped silicon layer;

and

in-situ depositing a third non-doped silicon layer on the second doped silicon layer in the opening, wherein the third non-doped silicon layer fills the opening.

- [c3] 3.The method of claim 2 wherein after depositing the third non-doped silicon layer, the method further comprises the following step:
performing a chemical mechanical polishing (CMP) process to remove the silicon layers outside the opening, leaving the first doped silicon layer, the second doped silicon layer, and the third non-doped silicon layer in the opening to form a conductive plug.
- [c4] 4.The method of claim 1 wherein the diffusion region is a N⁺ diffusion region, and wherein the first and second transient pure phosphor films are both formed by CVD.
- [c5] 5.A method for making a conductive plug, comprising:
providing a substrate having thereon a first device;
depositing a dielectric layer on the substrate;
forming an opening in the dielectric layer, the opening exposing a part of the first device on the substrate;
depositing a first non-doped silicon layer in the opening;
in-situ depositing a first transient pure phosphor film on the first non-doped silicon layer in the opening, wherein

phosphor atoms of the first transient pure phosphor film diffuse into the first non-doped silicon layer in no time to form a first doped silicon layer; and
in-situ depositing a second non-doped silicon layer on the first doped silicon layer in the opening.

[c6] 6.The method of claim 5 wherein after depositing the second non-doped silicon layer on the first doped silicon layer, the method further comprises the following steps:
in-situ depositing a second transient pure phosphor film on the second non-doped silicon layer in the opening, wherein phosphor atoms of the second transient pure phosphor film diffuse into the second non-doped silicon layer in no time to form a second doped silicon layer;
and
in-situ depositing a third non-doped silicon layer on the second doped silicon layer in the opening, wherein the third non-doped silicon layer fills the opening.

[c7] 7.The method of claim 5 wherein the first device is a layer of metal interconnection.

[c8] 8.A method for making a conductive plug, comprising:
providing a semiconductor substrate having thereon a dielectric layer, wherein an opening is formed in the dielectric layer;
situating the semiconductor substrate in a CVD vacuum

chamber; and

alternately introducing silane gas and phosphine gas into the CVD vacuum chamber and undergoing a chemical vapor deposition reaction to deposit a plurality of pure silicon layers and pure phosphor films on the dielectric layer and also in the opening, wherein each of the pure phosphor films is interposed between two of the pure silicon layers, and phosphor atoms of the pure phosphor films diffuse into adjoining pure silicon layers.